

## CLAIMS

1. A multiplexing QAM (Quadrature Amplitude Modulation) apparatus comprising:
  - a QAM unit that generates a plurality of QAM-modulated waves by QAM-modulating a plurality of input data with a common carrier frequency; and
  - 5 a modulated waves combining unit that generates a multiplexed QAM-modulated wave by combining said plurality of QAM-modulated waves together, wherein
  - said modulated waves combining unit gives a gain difference to said plurality of QAM-modulated waves to be combined together, so that symbol positions of said multiplexed QAM-modulated wave combined do not coincide with each other.
- 10 2. The multiplexing QAM apparatus according to claim 1, wherein said QAM unit gives a phase difference to at least two of said QAM-modulated waves.
3. The multiplexing QAM apparatus according to claim 1, wherein said modulated waves combining unit makes a transmitting power of said multiplexed QAM-modulated wave identical to that of another QAM method used on a same transmission line.
- 15 4. The multiplexing QAM apparatus according to claim 1, further comprising a frequency multiplexing unit that frequency-multiplexes a plurality of multiplexed QAM-modulated waves having different carrier frequencies.
5. A multiplexing QAM demodulation apparatus which demodulates a reception signal of a multiplexed QAM-modulated wave transmitted from a multiplexing QAM apparatus and
- 20 determines a plurality of differential-gain-multiplexed input data, comprising:
  - a probability calculating unit that calculates probabilities that said reception signal corresponds to respective symbol positions, based on variance of symbol positions caused by a transmission line; and
  - a demodulation unit that calculates an expectation value of each of said plurality of
  - 25 differential-gain-multiplexed input data, based on said probabilities that said reception

signal corresponds to said respective symbol positions, and estimates said input data based on said expectation value of said input data.

6. The multiplexing QAM demodulation apparatus according to claim 5, wherein said demodulation unit first estimates said input data having been given a larger modulated wave gain in multiplexing, and then estimates remaining input data while eliminating improbable symbol positions from the estimated input data.

7. A multiplexing QAM demodulation apparatus which demodulates a reception signal of a multiplexed QAM-modulated wave transmitted from a multiplexing QAM apparatus and determines a plurality of differential-gain-multiplexed input data, comprising:

10 a judgment unit that estimates individual symbol positions which appear in the received multiplexed QAM-modulated wave based on both a symbol position arrangement of said multiplexed QAM-modulated wave and a characteristic of a transmission line, determines a most probable symbol position based on distances between the estimated individual symbol positions and a symbol position of said reception signal, and then  
15 determines said plurality of input data from the determined symbol position.

8. A multiplexing QAM demodulation apparatus which demodulates a reception signal of a multiplexed QAM-modulated wave transmitted from a multiplexing QAM apparatus and determines a plurality of differential-gain-multiplexed input data, comprising:

a training unit that receives a prescribed training signal transmitted from said  
20 multiplexing QAM apparatus during an initialization period of signal transmission, and determines, based on said training signal, by operating with said multiplexing QAM apparatus, at least one parameter among: a QAM value of respective QAM-modulated waves to be differential-gain-multiplexed into said multiplexed QAM-modulated wave; a gain difference between said QAM-modulated waves; and a phase difference between said  
25 QAM-modulated waves, so that a proper inter-symbol distance of said multiplexed

QAM-modulated wave can be secured after the reception.

9. A communication method comprising the steps of:

generating a multiplexed QAM-modulated wave using a multiplexing QAM apparatus; and

5 transmitting the generated multiplexed QAM-modulated wave to a communication destination.